

Proposal for a Beryllium Window Test in the A0 Area

1. Introduction

The use of beryllium windows is one of the most critical issues to be tested in the experimental set-up for the muon cooling experiment. The windows are used to enhance the accelerating field on axis by closing the diaphragm in the iris and making $E_{\text{peak}} \equiv E_{\text{acc}}$, which is especially desirable in the muon cooling channel because gradients as high as 35 MV/m are used. If this concept for some reason fails, the only possibility would be to increase the Peak power by almost a factor of four to come up with a comparable accelerating field.

The test of beryllium in an environment with high electromagnetic field, during vacuum conditioning, breakdown, field emission etc is therefore one of the critical subjects to be studied in a dedicated test facility with original size beryllium windows (16 cm diam.) in Lab G. Nevertheless, the set-up of this test Lab will not be finished before summer next year and more immediate studies should be started as soon as possible. In order to come up with reasonable R & D steps performed in the near future a schedule has been discussed among the muon cooling collaboration at Fermilab to start immediately.

2. Short Term Plans for the Near Future

In terms of hardware development, incorporation of a beryllium window test in the Lab G activities has been proposed (H. Edwards, private communication). This test involves the use of one of the spare high gradient rf guns being available in the A0 area. This is a 1+1/2 cell rf gun operating at a frequency of 1.3 GHz with a maximum input power of 5 MW and a peak field of approximately 36 MV/m or more. Therefore, in terms of peak power, the gun environment seems a perfect choice, although, pulse length, size of the window and average power is significantly different from the final design. On the other hand not much is known about the behavior of beryllium in a high e.m. field environment. First experience with three to four different thickness' of the windows will definitely help getting information about the operational detail mentioned above.

Geometrical constraints for the window

The only place which could be reasonably used for the window test inside the rf gun is the so called "button". This button is usually used as a cathode support and holder for photo-cathodes, which are mounted from the back within a vacuum system. The diameter

of the button, and therefore the maximum size for the window is 16 mm (diam). a technical solution for the joint between the button and the foil (e-beam welding, brazing, diffusion bonding whatever) would have to be worked out with a certified manufacturer and staff members at Fermilab.

Additional Hardware for the Set-Up in A0

For the set-up in A0 a number of modifications have to be made to the presently existing hardware. Although the klystron and the modulator, which are in place can be used, a waveguide connections is necessary from an existing switch (next to the klystron) to the second rf gun. The waveguides are available but additional seals and support etc has to be ordered. The gun will be placed towards the end of the existing cave in A0 and roughly 20 meter of waveguide is required. For the necessary cooling, support and shielding the existing infrastructure can be used or is in place already.

For the vacuum connection and set-up somewhat more hardware is required. A vacuum cross to inspect the window in situ after operation, a Faraday cup, a mirror going into the vacuum and a number of other items will have to be rebuild or modified to fulfill the needs for the experiment.

The Schedule

Due to the fact that most of the hardware is in place, the time limiting piece (critical path) will most probably be the manufacture of the beryllium window. On the other hand, in order not to interfere with the operation of the A0 – photo-injector, the hardware should be in place before middle of December. Both requirements in principle could be met due to the advantage of using existing infrastructure.

Appendix. Cost Estimation

| | | Quan | Cost, USD | Total cost, USD |
|-----------------------------------|---------------------------------|------|--------------|--------------------|
| 4 Buttons with BE win. | | | | 8.900 |
| | Drawings | 1 | 500 | |
| | Parts (flanges, copper tubes) | + | 200,00 | |
| | Welding or brazing on flange | + | 200,00 | |
| | Beryllium windows | + | 1.500,00 | |
| | Connection Be - tube | + | 200,00 | |
| A0 Vacuum Components | | | | 4.400 |
| | Drawings | 1 | 500,00 | |
| | Vacuum Cross | 1 | 800,00 | |
| | Faraday Cup | 1 | 200,00 | |
| | Vacuum components | 1 | 300,00 | |
| | Pump cart + mass spectr. | 1 | 1000,00 | |
| | Use equipment | | | |
| | Labor machine shop | 1 | 800,00 | |
| | Labor Brazing/welding | 1 | 800,00 | |
| A0 RF Components | | | | 1.500 |
| | Seals | 20 | 50,00 | |
| | Diagnostics | 1 | 500,00 | |
| Total | | | | 14.800 |